RED FLUORESCENCE AND 3-12 MICRON EMISSION IN NGC 2023, HD 44179, M 82, AND LYNDS 1780.

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A red excess observed by Cohen et al. (1975) in the Red-Rectangle (HD 44179), studied by Greenstein and Oke (1977) and attributed by them to a possible molecular fluorescence mechanism, has also been discovered in NGC 2023 by Witt et al. (1984) and analysed in subsequent work (Witt and Schild, 1986, 1988) in this and other nebulae. An unexpected red light excess has also been noticed in a high latitude dark cloud L 1780 (Lynds, 1962) by Mattila (1979).

The fluorescence has been attributed to hydrogenated amorphous carbon by Duley (1985), on the basis of laboratory work. Alternatively, transitions between electronic states of free polycyclic aromatic hydrocarbon molecules, by-passing the cascade along the vibrational states, has been considered by d'Hendecourt et al. (1986) and Léger et al. (1988). In L 1780, the red excess has been related to the 12 μm emission detected by IRAS by Chlewicki and Laureijs (1987).

A quantative comparison of the intensity of the red fluorescence and that of the 3 - 12 μm features is thus warranted in helping assess the physical properties of large interstellar molecules.

The red fluorescence radiation, F(R), appears as a bump on the spectra between 0.6 and 0.9 μm. Values were deduced from the spectra published by Witt and Schild (1988) for NGC 2023, Cohen et al. (1975) for HD44179, and by Mattila (1979) for the high latitude cloud L 1780. Corrections for the extinction, both interstellar and internal to the nebulae, were included.

The 3 - 12 μm brightness, F(IR), was obtained through integration of the spectra published by Sellgren et al.(1985) for NGC 2023, and by Russel et al. (1979) for HD 44179 after removal of a smooth continuum due to hot large grains (Dainty et al., 1985). For the cloud L 1780, F(IR) was deduced from the 12 μm IRAS in-band flux, which can be

shown to be about 0.77 of the 3 - 12 μm flux. The galaxy M 82 could be included by evaluating the red fluorescence flux superimposed on the smooth stellar spectrum measured by Peimbert and Spinrad (1970), and adopting the infrared spectrum published by Willner et al. (1977).

The values of the ratio of the fluorescence flux to the infrared flux, F(R)/F(IR), are summarized in table 1, where estimates of the radiation density have also been included.

Table 1. Summary of results.

Object	Fluorescence F(R) [w m^{-2}]	3 - 12 μm F(IR) [w m^{-2}]	F(R)/F(IR)	density [eV cm^{-3}]
NGC 2023	4.9 10^{-6} *	7.5 10^{-5} *	0.065	10 - 100
HD 44179	3.1 10^{-13}	1.9 10^{-11}	0.016	>100
M 82	1.8 10^{-21}	4.1 10^{-20}	0.044	100-1000
L 1780	2.4 10^{-8} *	1.2 10^{-7} *	0.23	0.4

*per steradian

As shown by Léger et al. (1988), large molecules or ions should exhibit fluorescence emission upon UV excitation, with a yield very sensitive to the number of atoms they contain, and to the energy of the UV photons. Léger's et al. original calculation has been extended to larger molecules, and the ratio F(R)/F(IR) computed. In any case, the exciting radiation field contains numerous hard photons, and the highest photon energy, E = 13.6 eV, is appropriate. The result is displayed on fig. 1 as a function of the number of atoms per molecules.

The sizes deduced from table 1 and fig.1 are of about 70 atoms for the nebulae, and 50 atoms for the interstellar cloud L 1780. They fall well within the range of sizes deduced by de Muizon et al. (1987) through an anlysis of the ratio of the intensities of the 3.3 μm and 11.3 μm lines obtained on 14 IRAS sources.
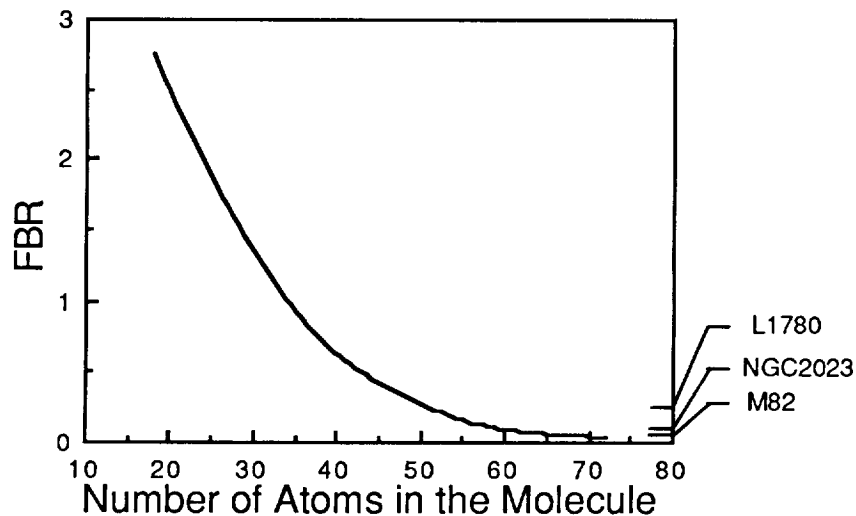
Figure 1. Ratio of the fluorescence flux to the infrared flux, FBR = F(R)/F(IR), as a function of the number of atoms in the aromatic molecules. Adapted from Léger et al. (1988). The exciting photon energy is 13.6 eV.

Red fluorescence and infrared radiation are two separate ways to access to the size of the molecules through observation, and it is rewarding that both approches give similar results. These findings bring a striking coherence into the physical description of the paricles, and add further support to the initial attribution of the infrared features to polycylic aromatic hydrocarbons (PAH).

A detailed account of this work will be presented elsewhere (submitted to Astronomy and Astrophysics).

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